Kent Downs
Area of Outstanding Natural Beauty

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FARMING FOR THE NATION
AONB Tests & Trials for the ELM Scheme

Viticulture ELM Test and Trials
Draft
Recommendations

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VINESCAPES
VINEYARD & WINERY CONSULTANTS

This report has been prepared by Vinescapes and the Kent Downs AONB Unit based on research work carried out by:

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The Viticulture Test and Trial is being carried out by the National Association for the Areas of Outstanding Natural Beauty on behalf of Defra. It is part of the development of the Environmental Land Management Scheme (ELM).

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1. Executive summary

In the 25-year Environment Plan Defra set out their comprehensive and long-term approach to protecting and enhancing natural landscapes and habitats across the UK. The Environmental Land Management (ELM) plans are being developed across the county to deliver these goals through six public goods and in 2019 Kent AONB was awarded the ELM test and trial in relation to Viticulture to identify key mechanisms within the sector that can deliver public goods.

This report and its recommendations have been derived from expert best practice studies commissioned as part of this work (Retallak, 2020; Wratten, Cairns, & Tarjomi, 2020; Vinescapes, 2020a). They are also informed by interviews with grape growers undertaken during the course of this study (March to September 2020) (see summary report), the 25-year Environment Plan goals and climate change projections for southern England over the next 50-years. In the next stages of this project these draft recommendations will be reviewed and refined with English viticulture groups. Subsequent updates incorporated into the recommendations will be provided to Defra in 2021.

In this report we recommend that the viticulture ELM scheme rewards public goods that go beyond those targeting sustainability and into the informed value-added delivery of specific ecosystems services. In summary it is therefore recommended that:

Wine grape growers are rewarded through Environmental Land Management (ELM) for practices which enhance long-term functional ecosystem services and public goods within vineyards and their setting. The enhancements should be regenerative and deliver healthy and thriving environments.

Vineyards are multifunctional farming environments that provide opportunity for multiple ecosystems services. Central to many of the provisioning, regulatory and supporting ecosystem services targeted by these draft recommendations is soil, water, and air. The Cultural ecosystem services relate strongly to inspiration, recreation, and tourism. Detailed draft recommendations can be found in Section 5.

The recently launched Wines of Great Britain (WineGB) sustainability scheme (Sustainable Wines of Great Britain; SWGB) (2020c) provides an operating framework for growers to follow best practice sustainability guidelines and gain certification. However, it does not provide a guarantee of enhanced ecosystem service delivery, nor reward for such. Some of the draft recommendations for ELM interventions and funding, as set out in Section 5, have mutual synergy with the SWGB scheme and also other schemes such as certified Organic or Biodynamic production. Reward / funding for Best Practice (whether implemented independently or as part of a 'sustainability' scheme) is considered appropriate in the context of ecosystem service enhancements that deliver public goods beyond those that just attract a market value reward. Many of the draft recommendations presented in Section 6, look beyond sustainability and into land regeneration.

Wine grape growers in the Kent Downs and Surrey Hills Areas of Outstanding Natural Beauty (AONBs) and the South Downs National Park (SDNP) were interviewed as part of this

Viticulture ELM Test & Trials process (see Kent Downs Viticulture Test & Trials 1-1 report - milestone 2, 2020, and Retallack, 2020) and it was found that many have adopted some elements of sustainable good practice. However, the ecosystem benefits of many of the activities undertaken are by and large unquantified and the rationale behind some of the practices employed was not informed and neither the value nor reward evident. Here, for example, an ELM scheme could provide both the knowledge and reward required for enhanced, functional, and regenerative ecosystem service delivery.

Through discussion and interviews with growers as part of this project, several barriers to adoption of the proposed ecosystem service enhancements were raised, particularly in relation to training, knowledge and funding. It is therefore required, within any ELM scheme, to provide technical support to growers to research, plan, implement and maintain new areas of ecological restoration and enhanced provisioning, regulating and supporting ecosystems services, to ensure the success of a viticulture ELM.

2. Defra's vision and ELM scope

As set out by Defra in their ELM presentation 'Our vision for a future Scenario' (2020), their vision includes:

a. Rewarding public goods with public money.
    i. Public Goods: Things that benefit more than just the recipient and cannot be rewarded by the market alone.
b. A self-reliant and thriving farming sector.
c. A trusting and productive relationship between farmers and government.
d. World class animal welfare standards.

As set out in the 25 Year Environment Plan (Defra, A Green Future: Our 25 Year Plan to Improve the Environment, 2018) the Environmental Land Management scheme (ELM) is a key mechanism for delivering this vision across the 6 public goods, set out below:

a. Clean and plentiful water.
b. Clean air.
c. Mitigation of and adaptation to climate change.
d. Protection from and mitigation of environmental hazards.
e. Thriving plants and wildlife.
f. Beauty, heritage, and engagement.

3. Viticulture Test & Trials objective:

To test with stakeholders (co-creation) the scope and ability for the new ELM system to deliver multiple broad and innovative environmental, social and economic objectives as identified in the 25 Year Environment Plan (Defra, A Green Future: Our 25 Year Plan to Improve the Environment, 2018).

4. Background

4.1. Opportunity

Agriculture sits at the nexus of some of the world's most pressing challenges: climate change, food security and nutrition, water and soil quality, biodiversity and sustainable livelihoods. We are entirely dependent on our climate, natural resources and the ecosystem services they provide (see Figure 1 for Ecosystem Service Types).

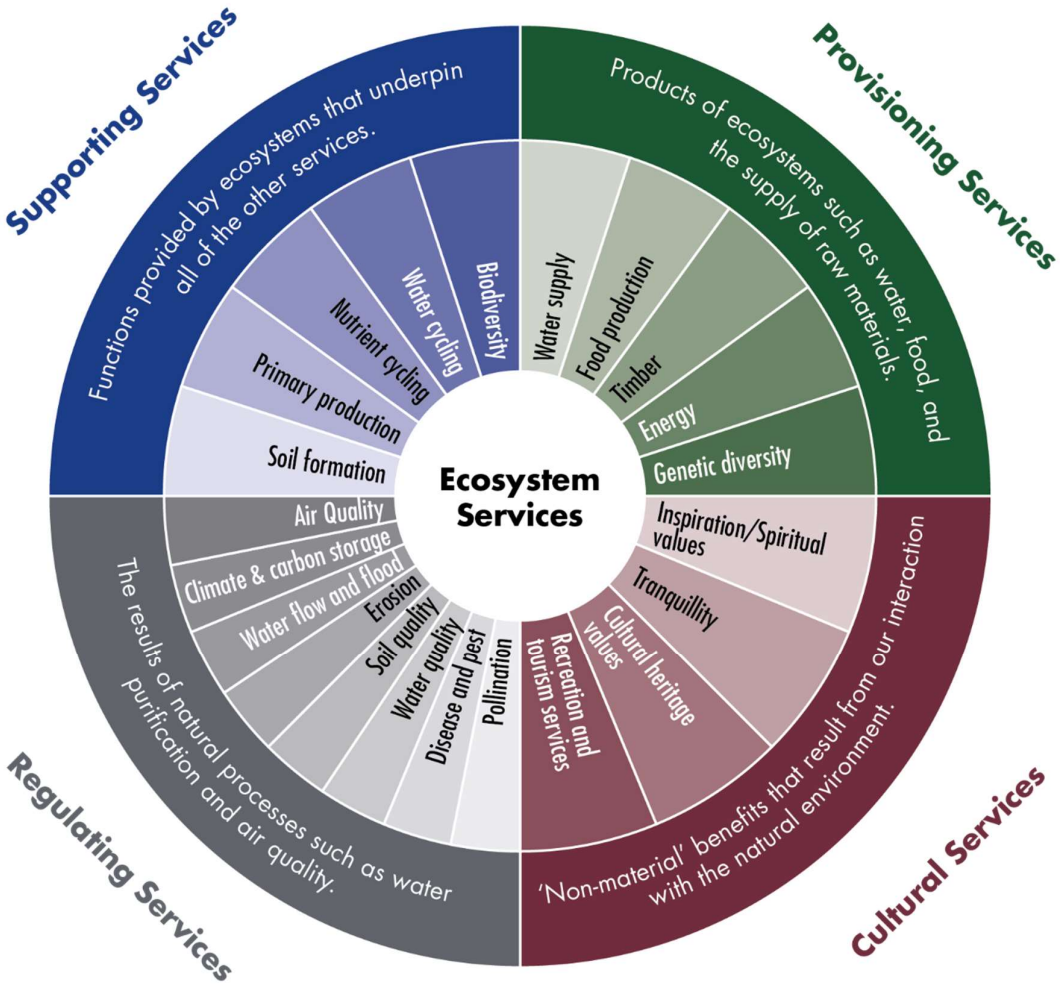

Figure 1. Ecosystem Service Types (SDNPA, 2019)

Healthy ecosystems provide services that are the foundation for human wellbeing, and it is in our best interest to value and preserve them. Ecosystem services that can be enhanced in vineyard environments, beyond those for direct commercial gain (e.g. the primary production of grapes), include:

- The **Provision** of genetic diversity and food [other than grapes].
- The **Regulation** of pests, water and soil quality, erosion, water flow and flood risk, carbon storage, and air quality.
- **Cultural** services relating to inspiration, heritage values, tranquillity, recreation, and tourism.
- **Supporting** functions of soil formation, nutrient and water cycling, and biodiversity.

The opportunity to enhance ecosystem services in UK vineyards coincides with a recent rapid expansion of vineyard numbers and area (hectares). Figure 2 below shows the increase at a national level over the last ~30-years. At a regional protected landscape level (relevant to this test and trials project) there are 36 vineyards covering approximately 680 ha in the Kent Downs AONB, 51 vineyards covering 440 ha in the SDNP and 11 vineyards covering approximately 120 ha in the Surrey Hills AONB.

The presence of commercial vineyards in England and Wales today is mainly attributed to suitable climatic conditions, in particular to growing season air temperatures; indeed, during a period of lower temperature, known as the Little Ice Age (from the 16th to the 19th centuries), the number of vineyards in the UK declined. The subsequent revival of UK viticulture began in the early 1950s and, up until 1993, the volume and spatial distribution of UK vineyards continued to increase. From 1993 to 2004, however, both vineyard area (total area) and numbers declined by 29% (see Figure 2), which has been attributed to a combination of factors, including sub-optimal varieties for the climatic conditions, poor vineyard site selection, poor wine quality, high costs, low yields, strong international competition and marketing difficulties. Since then, however, a significant increase in the area under vine to approximately 3000 ha has been accompanied by an increase in vineyard numbers to more than 750 in 2019 (Figure 2). This turnaround was primarily triggered by the production of award-winning sparkling wine from Nyetimber and the associated realisation that high-quality wines could be made in England using the classic Champagne varieties of Chardonnay, Pinot Noir and Meunier.

Recent vineyard plantings have predominantly occurred in southern England (50 – 52^{o}N), with vineyards in south-east (East and West Sussex, Kent, and Surrey) and south-central (Berkshire, Hampshire, the Isle of Wight, and Wiltshire) England accounting for around 70% of the UK total. Most large commercial vineyards are located within south-east and south-central England.

Data from the UK Vineyard Register (Food Standards Agency, 2019) shows that the average vineyard size in the UK has increased from 1.98 ha in 1989 to 3.41 ha in 2018. Total UK vineyard area is greater than that of another emerging cool-climate sparkling wine-producing region, Tasmania (approximately 2000 ha) (Wine Tasmania, 2019), but significantly smaller than another closer and long-established producing region, Champagne in France, which extends over 35,000 ha, growing predominantly the same varieties as in the UK (Comité Champagne, 2020).

English sparkling wine in particular has received significant national and international acclaim for its quality. Whilst not all English sparkling wine is of an exceptional standard, those that are have been heralded by wine critics, competition judges, the wine (and other) media and

customers as prestigious. Indeed, increasing recognition for its quality and associated awards were contributing reasons cited by English wine producers (in a 2015 survey) as drivers for recent growth of the sector (Nesbitt, Kemp, Steele, Lovett, & Dorling, 2016).

The recent rapid expansion of viticulture in England and Wales is predicted to continue, with a potential 40 million bottles of English wine being produced annually by 2040 and a potential retail value of £1bn or more (Wine GB, Looking to the future, 2018). Indeed, research conducted by Nesbitt et al. (2018) identified over 35,000 ha of prime (unplanted) viticulture land in England and Wales.

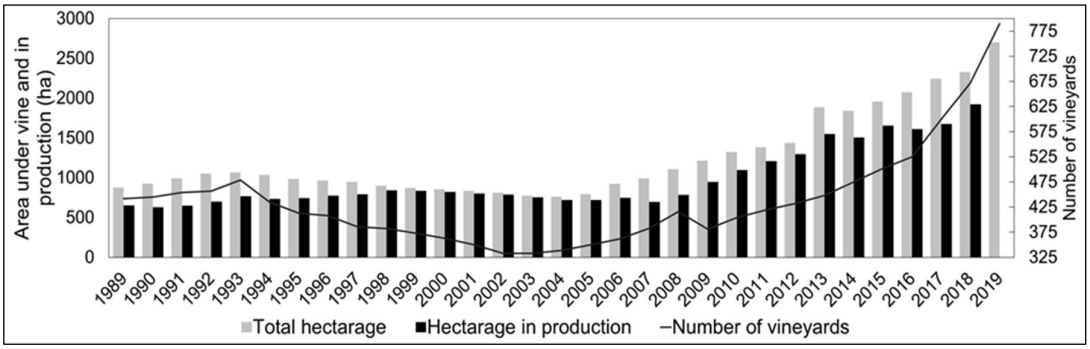

Figure 2. UK hectarage under vine and vineyard numbers (1989 – 2019). Data source: (Food Standards Agency, 2019) and Vinescapes and the Kent Downs AONBs own research.

The UK's 5-year average bottle production between 2014 and 2018 was 6.92 million/year, although 2018 was an exceptional year in which 13.2 million bottles were produced (Wine GB, Looking to the future, 2018). WineGB's chairman has stated: '*English and Welsh wine is seeing growth far exceeding any industry forecasts and the sector is the bright light in UK agriculture with vineyards being planted across the breadth and depth of our island*' (Wine GB, An Industry Coming of Age, 2019). WineGB's research suggests that there is now the equivalent of approximately 2,100 full-time employees involved in the UK wine production sector and that by 2040 this employment level could grow to approximately 30,000.

However, despite English sparkling wine in particular receiving significant acclaim and winning international recognition for its exceptional quality (Wine GB, Other competitions, 2020a), doubts have recently been raised about the market viability of immediate and sustained rapid sector growth (Wine GB, Marketing Conference, 2020b). Increasing market competition, low yields by international standards, high production costs, global reductions in alcohol consumption, and a variable climate present production and financial challenges for many UK grape growers and wine producers. As such, despite the predictions of expansion, it should be noted that the precise growth trajectory for viticulture in England and Wales remains uncertain.

Therefore, in relation to ecosystem service and public good opportunities, established and new vineyards that adopt such practices (see Section 5) not only present an increasing opportunity but would benefit from rewards / funding. Growers interviewed as part of this study (and others: see the SDNPA Viticulture growth Impact Assessment (Vinescapes, 2020)

are keen to be better custodians of the environment in which they operate. They recognise that vineyards have 80-95% of ground area unplanted with vines, or covered by the vine canopy (this is vastly more 'available' land than found in arable farming), presenting significant areas of land for increased biodiversity and public good. They also recognise the market shift, opportunity and need for 'clean green' products, see Milestone 2 report (Kent Downs AONB, 2020).

4.2. Existing challenge

The existing challenges that an ELM scheme for UK viticulture could help overcome includes:

1. Limited knowledge: The degree of benefit from, or risk to specific ecosystem services in vineyards is often determined by the management approach, which in turn is influenced by knowledge, resource availability and regulation. Funding and knowledge (research & education) were the two most important factors that producers raised [in 1-1 interviews] as barriers to adopting more or better ecosystem service enhancements, and critically to being able to quantify the ecosystem service potential.
2. Low financial reward: The present grape grower focus on public goods through ecosystems service provision in UK vineyards is low and ad hoc, the uptake of existing countryside stewardship opportunities is limited. This may be due to the small scale of some vineyards and therefore limited 'compensation' potential; the lack of focus on countryside stewardship within a production 'system' focussing on the other end of the production business, i.e. wine and markets; or, the lack of time and effort to apply for such schemes, potentially related to the perceived small reward vs crop value (see Milestone 2 report, Kent Downs AONB, 2020).
3. Market incentive: Practice regulation is lighter for vineyards than some other forms of farming (e.g. animal welfare). This may stem from a traditional lack of market focus on 'sustainability' and provenance in English wines than is afforded to other foodstuffs. The recently launched WineGB sustainability scheme (SWGB) (2020c) provides no guarantee of enhanced ecosystem service delivery, although it does provide an operating framework for growers to follow best practice guidelines and gain a certification. The same is true for other schemes such as the Linking Environment and Farming (LEAF) scheme. In some areas therefore the recommendations for ELM interventions and funding set out in Section 5, have mutual synergy with the SWGB scheme. Likewise, for those following certified Organic or Biodynamic production schemes. In other words, rewards / funding for some existing Best Practice is considered appropriate in the context of ecosystem service enhancements.

Wine grape growers in the Kent Downs and Surrey Hills AONBs and the SDNP were interviewed as part of this Viticulture ELM Test & Trials process (see Viticulture Test & Trials 1-1 report, Kent Downs AONB, 2020) and it was found that many have adopted, at least on part of their vineyard estates, practices to promote biodiversity, reduce pesticide and herbicide use, reduce water runoff and water use (through reduced spraying), reduce erosion, reduce pollution (through reduced tractor passages), and means of 'enhancing' the vineyard aesthetics and attracting people into the vineyard. The impetus is being derived from

Countryside Stewardship or Sustainability/Organic/Biodynamic scheme membership, a desire to be better custodians of the environment, and an awareness of public perception. However, the ecosystem benefits of many of the activities undertaken are by and large unquantified and the rationale behind some of the practices employed was not informed and neither the value nor reward evident. Here, for example, an ELM scheme could provide both the knowledge and reward required for enhanced, functional, and regenerative ecosystem services.

4.3. Public good

Market-based incentives may exist for provision of enhanced ecosystem services, such as weed suppression or pest control for instance, premium prices or higher demand for wine from 'clean green' vineyards that promote biodiversity-friendly business. However, other ecosystem services may be public goods and lack any direct financial incentive to the grower; conservation, cultural value and aesthetics are examples. This involves paying for ecosystem services which have value beyond the vineyard (Orre-Gordon, Jacometti, Tomkins, & Wratten, 2013).

5. Draft recommendations for ELM scheme interventions

We recommend that the ELM scheme for Viticulture rewards public goods that go beyond just those targeting sustainability and into the informed value-added delivery of specific ecosystems services. These in turn will deliver a self-reliant and thriving Viticulture sector. Draft recommendations relating to those ecosystem services are set out in Tables 1 & 2.

In summary we propose that:

Wine grape growers are rewarded through Environmental Land Management (ELM) for practices which enhance long-term functional ecosystem services and public goods within vineyards and their setting. The enhancements should be regenerative and deliver healthy and thriving environments.

To enhance multiple long-term ecosystems services in vineyards there are three key recommendations (expanded on in Tables 1 & 2):

1. Growers are rewarded for measures that restore the full potential of supporting and functional ecosystem services. These measures include biological control – supported by biodiversity and native insectary plants, weed suppression, erosion control, nutrient cycling, soil organic carbon and soil biological activity and soil water retention.

2. Growers are rewarded for strategies that transition their businesses to the post-carbon economy by 2040, who achieve zero carbon dioxide emissions and enhance carbon sequestration. These climate change mitigants include soil regeneration, use of renewable energy and optimising sequestration potential.

3. Growers are rewarded for enhancing cultural ecosystem service delivery from vineyards. These services should go beyond those just for direct market reward and into facilitation of health and wellbeing through recreation opportunities, engagement and education, tranquillity and inspiration, and heritage value.

Each of these recommendations is set out with the potential interventions, rationale, and benefactors in Tables 1 & 2.

Table 1. Draft recommendations for provisioning, supporting and functional ecosystem services

Relevant to ELM themes: a, b, c, d, e, and f.

Recommendations	Potential interventions	Rationale and Benefactors
1. Growers adopt measures that restore the full potential of supporting and functional ecosystem services. These measures include biological control – supported by biodiversity and native insectary plants, weed suppression, erosion control, nutrient cycling, soil organic carbon and soil biological activity and soil water retention.	a. A fully integrated approach to pest management which includes the use of biocontrol, cultural, and targeted chemical intervention (only if required) to reduce pest insect populations below damaging levels. i. <u>Biocontrol</u>: Establishment of locally adapted native insectary plants (in preference to introduced	**Benefactors:** We are entirely dependent on our natural resources and the ecosystem services they provide. Healthy ecosystems provide services that are the foundation for human wellbeing, and it is in our best interest to value and preserve them. UK vineyard land cover is circa 20% vines, with trunks only taking up less than 5% of vineyard area, the remaining vineyard area offers significant potential for enhanced ecosystem services and soil regeneration. a. **Rationale:** Insect pests cause economic damage in UK vineyards each year (Retallak, 2020). There are a range of biocontrol agents available (predatory insects, spiders, parasitic wasps, bats, and insectivorous birds). Biocontrol is estimated to provide five to ten times more control of pests than pesticides. It is estimated that 98% of sprayed insecticides and 95% of herbicides miss their intended target species (Retallack, 2020). A reduction in chemical use will reduce off target damage to predators and plants, reduce the likelihood of pest resistance, pollution of waterways and air, contribution of greenhouse gasses through the use of fossil fuels and reduce damage to soils through compaction, erosion and accumulation of chemicals toxic to soil dwelling arthropods and microorganisms. i. **Rationale:** Conservation biological control involves the conservation and augmentation of predator species that are already in place or have the capacity to be readily available in association with production systems. This can be achieved through the incorporation

		/ non-native species) in and around vineyards in strategic locations to provide habitat for predatory species that contribute to the biocontrol of economically damaging insect pests.	of native insectary plants which provide food, shelter and alternative prey/parasitoid hosts and habitat for higher order predators including bats. *Native grasses provide a* valuable complementarity habitat for arthropod species other than those commonly found in association with native woody perennial shrubs and may increase the net number of predator morphospecies by around 27% when planted in association with vineyards (Retallak, 2020). It may be possible to increase the functional diversity of predatory arthropods by more than 3x when native shrubs are present versus grapevines only. A list of potential plants is provided in the Retallack and Bio Protection reports (Retallak, 2020; Wratten, Cairns, & Tarjomi, 2020).
	ii.	<u>Biocontrol</u>: Incorporate the use of species-specific predator perches and/or nesting boxes to support populations of predatory (including the endangered honey buzzard and tawny owl) and insectivorous birds.	ii. **Rationale:** Predatory birds such as the barn owl, buzzard, honey buzzard, goshawk, sparrowhawk, kestrel, long-eared owl, red kite, and tawny owl will feed on a range of lower order mammals, birds and/or insects. If they are territorial, they may patrol the perimeter of the vineyard and help keep fructivorous birds at bay, as well as helping to control rodent pest species.
	iii.	<u>Biocontrol:</u> Incorporate the use of native insectary shrubs and trees that support populations of insectivorous birds.	iii. **Rationale**: Insectivorous birds (including the endangered swift, nightjar, cuckoo, house martin, pied flycatcher, nightingale, spotted flycatcher, dunnock, wood warbler, and willow warbler), contribute to the biocontrol of economically damaging insect pests.

	iv. <u>Biocontrol</u>: Incorporate bat boxes to supplement natural habitat and boost the presence of bats in and around vineyards.	iv. **Rationale:** Bats are reported to eat up to half their body weight in insects at night and can contribute to the biocontrol of economically damaging insect pests. Predation on agricultural pests by insectivorous bats may enhance the economic value of agricultural systems by reducing the frequency of required spraying and delaying the ultimate need for new pesticides.
	b. A targeted approach to enhance above and below ground functional biodiversity through regeneration.	b. **Rationale:** Enhanced and functional biodiversity addresses a key current challenge: to maintain or enhance productivity of agro-ecosystems in a sustainable way. This can be achieved in vineyard environments by increasing the role that ecosystem services play, whilst at the same time maintaining ecological integrity in the cultural landscape. South England chalk downlands for example can have more than 40 plant species/m^{2-} similar in many ways to tropical rainforest! Yet, conversely, many vineyards in the protected landscapes of the Kent Downs AONB, Surrey Hills AONB and in the South Downs National Park (SDNP) are established on shallow soils over chalk geology, or on free draining soils, and often replacing arable crop rotations. These 'thin' soils are prone to erosion, degradation, and loss of fertility where they are managed using 'conventional' viticulture methods, i.e. herbicide applications, maintenance of bare soils (under vine) and a lack of focus on biodiversity. There is opportunity to regenerate vineyard soils, contribute to their re-carbonization and at the same time help reduce erosion risks, aid water flow, use the soil medium as a means of pest management, provide genetic diversity and support above ground biodiversity. Soil regeneration (see also recommendation 2ai) and functional biodiversity enhancements are critical to not only fulfilling international agreements on biodiversity protection, but also for the commercial benefit of an authentic 'clean green' brand. Meeting these challenges has been called 'sustainable intensification' (Garnett, et al.,

		2013; Pretty & Bharucha, 2014). Enhancements of viticulture biodiversity can help translate ecosystem science into action, thereby supporting the goals of the intergovernmental science-policy platform on Biodiversity and Ecosystem Services (www.ipbes.net).
	i. <u>Biodiversity/biocontrol</u>: Incorporation of a diversity of native insectary plants to provide functional biodiversity benefits throughout the entire year. These plants include ground cover (grasses, forbs, and prostrate growing plants) shrub and tree species.	i. **Rationale:** Locally adapted, native insectary plants are preferred as supplementary flora, as they are naturally adapted to local climate conditions and are consistently reported as having a low occurrence of pests and a high occurrence of pest enemies. Enhanced functional biodiversity can lead to greater natural biological control, resilience within the system and improved ecosystem services. The resilience of a system describes its capacity to reorganise after local disturbance. The recent '*Plants for Bugs'* study at RHS Wisley (2009) also found that the best way to support the presence of invertebrates and promote a healthy ecosystem is to choose plantings biased towards British native plants. It is generally regarded that if greater diversity and species richness are present, then it is less likely that individual weeds or arthropod pest species will dominate. The strategic use of native insectary plantings, both spatially and temporally is important to deliver insectary services when they are needed.
	ii. <u>Biodiversity</u>: Establish inter-row and under-vine native and locally adapted species. Also establish beneficial plants in headlands and unplanted areas of the vineyard to provide functional and	ii. **Rationale**: When undertaken in an informed and targeted way inter-row and under-vine cover provides biodiversity, habitat for beneficial pest predators (as it provides them with natural resources: pollen, nectar, alternative prey, shelter and water), reduces mowing requirements, reduces herbicide and/or under vine cultivation, dissipates and improves rainwater infiltration, helps retain soil moisture, reduces the risk of erosion and water runoff and improves soil fertility. They increase soil nitrogen and organic matter and the

	enhanced biodiversity. This includes establishing them in/as windbreaks.	soil cation exchange capacity, improve soil structure and aggregate soils (as fine roots penetrate the soil profiles), improve beneficial microbial communities and increase the likelihood of fungal colonisation of grapevine roots, facilitating the transfer and uptake of nutrients (Shields, Tompkins, Saville, Meurk, & Wratten, 2016). A list of potentially beneficial species is presented in the Bio-Protection report (Wratten, Cairns, & Tarjomi, 2020), but two non-native examples are provided here purely for illustrative purposes: - Buckwheat nectar can enhance the longevity of beneficial parasitic wasps (from 3 to 42 days). This leads to a higher parasitism rate of key pests, including the key parasitoid of the light-brown apple moth. Other natural enemies of this caterpillar and other pests such as the spotted-winged drosophila are likely also to benefit from buckwheat nectar. - Phacelia nectar will benefit honeybees and bumble bees greatly, so the vineyard will deliver fitter bees to adjacent crops, thereby delivering ecosystem services (pollination and honey production) beyond the vineyard. Careful and informed management of species rich swards, under-vine plants and vineyard ground vegetation will be required (not least to manage humidity levels). Regular mowing maybe too severe for some plants (the planting of chalk grassland prostrate plants would be more beneficial in suitable locations and therefore require almost not mowing during the season) and this may present opportunity for in-vineyard grazing to keep the grass down as well as poaching the ground initiating the resident dormant seed bank to grow in the spring. In New Zealand, Oregon and England some growers have used Old English Southdown (Baby Doll) sheep for this

		purpose. They can be easily managed and are too short to reach grapes. Traditionally, chalk downland areas were a key part of sheep grazing regimes although the extent and frequency of this are crucial – see a classic paper on this by (Gibson, Watt, & Brown, 1987). Grazing or strimming will also reduce soil compaction. As an additional benefit of sheep grazing during the winter months sheep manure will be added to the vineyard. Where fencing is required (to keep sheep in) this could be eligible for ELM funding if no other option is available, the same could be applied to badger fencing, if not other control option is available. Suitable native plants / trees should be encouraged for use as windbreaks rather than the standard Italian Alder, likewise for infilling dead or poor-performing windbreak trees.
2. Growers adopt strategies that transition their businesses to the post-carbon economy by 2040, who achieve zero carbon dioxide emissions and enhance carbon sequestration. These climate change mitigants include soil regeneration, use of renewable energy and optimising	a. A targeted approach that sees vineyards actively contribute to the bioeconomy, eliminating GHG emissions and removing GHGs from the atmosphere by building healthy, biologically diverse and mineral-rich soils.	**Benefactors:** Climate change is the greatest environmental challenge facing the world. Greenhouse gases (GHGs) are disrupting and changing climates and in turn the natural environment which we rely on for human wellbeing. It is in everyone's interest to reduce GHG (in this case carbon based GHGs) emissions to sustainable levels. **a. Rationale:** Britain's Climate Change Act of 2008 introduced a national framework to tackle climate change, setting a legally binding target of an 80% reduction in GHG emissions by 2050 (against a 1990 baseline). Agriculture, and the land-based economy, can play a key role in tackling climate change because it is uniquely placed to capture the major greenhouse gas – carbon dioxide (CO_2). It is estimated that at least 50% of the carbon in the earth's soils has been released into the atmosphere over the past few centuries, partly due

sequestration potential.	i. Soil regeneration: Adopting and implementing practices that provide biocontrol and biodiversity-based ecosystem services (see Recommendations 1) and that also assist in regenerating vineyard soils. This includes phytoremediation.	to destructive agricultural practices. Action to tackle/mitigate climate change in UK vineyards requires a portfolio of different practices focused on three key themes: 1. Improving productive efficiency to reduce greenhouse gas emissions – enabling growers to produce the same quantity of grapes, or more, with less inputs and in smarter ways; 2. Improving carbon storage in soils and vegetation – improving land management and capturing more carbon, through targeted ground cover (see Recommendation 1), better hedgerow management, more woodland, and especially more carbon-rich soil; 3. Boosting renewable energy use and the bioeconomy to displace greenhouse gas emissions from fossil fuels and to create GHG removal through photosynthesis and carbon capture; and, 4. Using wooden rather than metal posts (if they are deemed to have a lower carbon footprint even when requiring replacing more often than metal posts?) and generally choosing lower carbon materials. i. **Rationale:** Soil loss and soil degradation is a significant UK and Global challenge (FAO, 2020). Healthy soils are essential to reducing greenhouse gas emissions and building resilience to climate change by maintaining or increasing their carbon content. Regenerating / repairing soils to increase their capacity, by building and managing soil carbon levels and the soil microbial network is key to arresting its decline. Having a diverse range of plant life storing and cycling carbon and increasing soil microbial diversity and activity through interaction with these plants creates a healthy, diverse, living soil microbial ecosystem that will produce high functioning soils.

		Soil regenerative techniques include using cover crops / ground cover (see recommendations: 1aii & iii and 1bi & ii), no tilling (which releases CO_2 back into the atmosphere and disturbs microbial communities in the soil), no pesticides or synthetic fertilisers, and bringing grazing animals back onto the land. Soil regenerative techniques also offer many benefits beyond carbon storage. They increase soil water holding capacity, help prevent soil erosion, protect groundwater quality, and set up the conditions for crops to become more disease and pest resilient. Chalk aquifers under the Kent and South Downs are highly productive and supply between 75-100% of ground water designated for public use in south-east England. Yet, they are very susceptible to leaching of nitrates and pesticides from agriculture (including viticulture). Phytoremediation (using plants to decontaminate land; see Trappey (2020a) should also be adopted including the use of hyperaccumulators (see Trappey (2020a), to prevent leaching into ground water.
	ii. <u>Renewable energy</u>: Installing charging points for electric vehicles including visitors' vehicles, tractors, ATVs; and using renewable energy powered vineyard equipment including Tractors, ATVs and Robotic vehicles.	ii. **Rationale:** Providing incentives to vineyards will facilitate, encourage, and speed up the adoption of renewable energy powered vehicles (including vineyard vehicles and robots), therefore reducing reliance on fossil fuel sources, and reducing pollution (noise and atmospheric).
	iii. <u>Sequestration</u>: Through permanent ground cover, evergreen shrubs and trees, and mulching of prunings (rather than burning).	iii. **Rationale:** See recommendations 1a and 1b for means of carbon sequestration in vineyard environments. In addition, the mulching of

		prunings, introduction of biochar and use of Power Plants provide further opportunity.

Table 2. Draft recommendations relating to cultural ecosystem services

Supporting and relevant to ELM scheme theme f.

Recommendation	Potential interventions	Rationale and Benefactors
3. Growers enhance cultural ecosystem service delivery from vineyards. These services should go beyond those just for direct market reward and into facilitation of health and wellbeing through recreation opportunities, engagement and education, tranquillity and inspiration, and heritage value. This includes vineyards developing a landscape plan which thinks about enhancing character	a. An integrated approach that builds on Recommendations 1 & 2 to target interventions and enhancements at the landscape (beauty), heritage and public.	**Benefactors:** Vineyards have a unique potential to provide cultural ecosystems services relating to inspiration, heritage values, tranquillity, recreation, and tourism. The story of wine provenance, that is so critical to its market, is told through the landscape, climate, soils, people and culture. By supporting interventions that promote these 'terroir' related aspects of grapes and wine, functional cultural ecosystems services can be enhanced for both producers and the wider communities in which vineyards operate. a. **Rationale:** Most UK vineyards (established geographically and/or commercially separate from winemaking facilities) are not open to the public and do not have tourism or market related functions or facilities. However, where they do, these include footpaths, cycle and/or walking trails, benches, shops, cafés, restaurants, tasting rooms, accommodation, car parking, cycle racks etcetera. These, and others (see below) are opportunities for cultural ecosystems delivery. The fact that most vineyards do not provide any, or only some of these functions or facilities suggests that the market alone may not reward such, even though they could / should be considered as offering opportunities for public good. Additionally, it is evident from the interviews conducted with growers, as part of this project, that landscape beauty, tranquillity, heritage,

but also removes detractors.		engagement, and wellbeing are not presently or consciously targeted as cultural ecosystem services that can deliver public good.
	i. <u>Inspiration</u>: Delivered through beauty, landscape enhancements and opportunity for engagement with growers/producers including signage explaining biodiversity and ecosystems services delivered in the vineyard.	i. **Rationale:** Inspiration in or from vineyard settings maybe somewhat subjective but Recommendation 1 set out the huge potential for biodiversity and biocontrol enhancements that themselves can be both educational and inspiring. Public prefer a scenic and aesthetically pleasing vista, which vineyards can remove, so interventions (recommended herein) to 'put back' functional biodiversity and aesthetics using flowering plants and native species will aid this process. The opportunity to tell the story of biocontrol, biodiversity and other ecosystem service contributions to the final products (grapes and wine) can itself be inspirational and of course of value to both visitors / customers and wider society. The Greening Waipara program in New Zealand involved the introduction of *Biodiversity Trails* in vineyards with signage (interpretive) explaining the ecosystem services of plants. These led to visitors spending more time in vineyards and being educated and inspired.
	ii. <u>Heritage values</u>: Vineyards should contribute to local and regional cultural heritage.	ii. **Rationale:** Vineyards (and wine production) can enhance an area's cultural heritage by virtue of creating it – through their enterprise and products. These can form part of regional identities, cultures and traditions. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has designated multiple vineyard landscapes (globally) as World Heritage Sites. Heritage and cultural services in the form of regional traditions (growing practices, varieties, wine styles etcetera) of wine production contribute to terroir, the '*sense of*

			place' that reflects the unique aspects of a growing region, with its typical winemaking traditions. Vineyard landscape plans will assist (with local expert help) in protecting and promoting heritage values and clusters of such.
	iii.	<u>Tranquillity</u>: Enhanced through Recommendations 1 and 2aii.	iii. **Rationale:** Tranquillity enhancements can be made in vineyards through electric vehicles, reduced passages, spraying, mowing etc. Aesthetically, ground cover and enhanced biodiversity softens the landscape change that vineyards bring. Where open to the public, vineyards and wineries can provide walking routes and benches or viewpoints from which people can enjoy the countryside, vineyard views, and rural environment, often with associated peace and quiet.
	iv.	<u>Recreation and tourism:</u> Supported through Recommendation 3a and 3ai.	iv. **Rationale:** As set out in Recommendation 3a, vineyards provide significant opportunity or recreation and tourism through facilities and/or infrastructure. All these open the countryside environment and provide opportunities for inspiration, education and enjoyment that contribute to Well Being of individuals and society at large.

6. Activities not recommended for funding

Several activities were requested (through the interviews conducted as part of this project) and/or considered as being potential candidates for this Viticulture ELM Test & Trial. These are listed below with reasons for not including at this point. However, through the next co-development phase of the project they may be further considered and introduced to the final recommendations. In no particular order these were:

1. Rainwater collection. Most vineyards don't have premises onsite to do so, other than potentially equipment storage sheds. Rainwater volume is minimal and there are other incentives to collect rainwater so it is not clear how the benefit could be quantified as an enhanced ecosystem service. Climate change modelling work regarding viticulture suggests it is not expected that irrigation will be required during the next 50 years, but if it became a requirement this would put increased pressure on water supplies (Adaptation of viticulture (ADVICLIM), 2020).
2. Adding winery pomace/marc back onto vineyards as compost. There seems little need for funding to do this other than if the winery is geographically separated from the vineyard, in which case transport (tractor and trailer / lorry etc) may be required.
3. Real time insights for targeting spray applications (rather than routine applications). These can be particularly valuable vineyard management tools (and are used by many vineyards) but evidencing the public good and quantifying the benefit as an ecosystem service is required…. as with other IoT, autonomous vehicles, robotics, drones etcetera. This evidence base may be provided by growers and could therefore be added to the recommendations, including to 2ai.

7. Barriers to adoption

Through discussion and interviews with growers as part of this project several barriers to adoption of the proposed ecosystem service enhancements were raised, and these are relevant to both the final recommendations and any resulting scheme uptake. In summary these include:

- **Time**: too much paperwork needed to access existing grant scheme incentives (see Milestone 2 report, Kent Downs AONB, 2020 and comments from FWAG).
- **Cost:** cost of undertaking additional work without suitable reimbursement. Some of the current grants available do not cover potential lost production.
- **Incentive**: growers would like more support to market the benefits as recompense for undertaking activities.
- **Flexibility**: the ELM needs to be flexible with regards to 'areas' you could pick.

Regenerative ecosystems services in particular will involve a degree of *'citizen science',* with trials and observation at its core. In-field trials and demonstration sites are needed to verify the suitability of the selected candidate native insectary plants for example (both the Bio-protection (Wratten, Cairns, & Tarjomi, 2020) and Retallack reports (2020) provide lists of potential plants), for use in and around vineyards and to help inform grower choices,

accelerate practice change and adoption. Implementing practices into a cohesive manageable system will differ from vineyard to vineyard as soils, management capability, environments (including topography and surrounding vegetation etcetera), adopted practices (including biodynamic and organic) will vary. There is not likely to be a one size fits all approach and execution will take discipline and patience as meaningful change will take time.

Provision is therefore required, within any ELM scheme, to provide technical support to growers to research, plan, implement and maintain new areas of ecological restoration and enhanced provisioning, regulating and supporting ecosystems services. In addition, this support could complement or be used to facilitate 'grower-to-grower' meetings. There is ample evidence world-wide that farmers are the best educators of farmers, operating in social networks rather than scientists trying to achieve and apply outcomes alone (McKelvey & Warner, 2008; González-Chang, 2020). These complementary activities will provide greater knowledge and confidence for growers.

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